REMARKS

Attached hereto is a Petition and Fee for an Extension of Time.

Applicant respectfully submits that entry of this §1.116 Amendment is proper. Since the amendment above narrows the issues for appeal and merely clarify the subject matter of the claims. Applicant further respectfully submits that such amendments do not raise a new issue requiring a further search and/or consideration by the Examiner. As such, entry of this §1.116 Amendment is earnestly solicited.

Claims 21-32 are pending in the application. This Amendment amends claim 21. No new matter is added to amended claim 21. Claim 21 is amended to merely clarify the subject matter of the claim and in no way narrows the scope of the claim in order to overcome the prior art or for any other statutory purpose of patentability.

Notwithstanding any claim amendments of the present Amendment or those amendments that may be made later during prosecution, Applicants' intent is to encompass equivalents of all claim elements. Reconsideration in view of the foregoing amendments and the following remarks is respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current Amendment. The attached page is captioned "**Version with markings to show changes made**."

Claims 21-27 stand rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,537,433 to Watanabe in view of U.S. Patent No. 5,557,115 to Shakuda. Claims 28-31 stand rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe modified by Shakuda as applied to claim 21 and further in view of U.S. Patent No. 5,977,565 to Ishikawa et al. (hereinafter, Ishikawa). Claim 32 stands rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe modified by Shakuda as applied to claim 21 and further in view of U.S. Patent No. 6,258,617 to Nitta et al. (hereinafter, Nitta).

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention is directed to *inter alia* a method of manufacturing a light-emitting device that includes forming a light-emitting layer comprised of $In_XGa_{1-X}N$ on a

sapphire substrate, in which the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level $Eg < (3.4 * (1-X)) + (1.95 * X) - (1.0 * X * (1-X))$, the light-emitting layer being devoid of an intentional impurity.

The dashed line of Fig. 1 and equation (2), that is, $Eg = (3.4 * (1-X)) + (1.95 * X) - (1.0 * X * (1-X))$, of the application represent the conventional understanding of the relationship between the mole fraction of indium, X, in a light-emitting layer of $In_XGa_{1-X}N$ and the photon energy of the emitted light , Eg, where no intentional impurities are added.

Experimental results by the inventors of the present invention have found that for a light-emitting device comprised $In_XGa_{1-X}N$, where no intentional impurities are added, and formed on a sapphire substrate, the relationship between the mole fraction of indium, X, and the photon energy of the emitted light, Eg, is

$$Eg = (3.4 * (1-X)) + (1.95 * X) - (4.26 * X * (1-X)).$$

Because the coefficient of the third term of the equation, immediately above, is greater than that of conventional equation, the photon energy for a particular indium mole fraction will, of necessity, be less than that of the conventional equation, while the associated wavelength, λ, being inversely proportional to the photon energy, will be greater.

II. THE PRIOR ART REJECTIONS

A. The Watanabe Reference

Watanabe discloses a semiconductor light emitter including (a) a total reflection layer(s) arranged between the transparent layer(s) and the opaque layer(s) (Abstract, lines 7-9). The refractive index of the total reflection layer is smaller than that of the transparent layer, so that, at least one part of the light, which has been radiated from the light emitting area or the active layer and which has been reflected by the total reflection layer is either radiated outward from side surfaces of the transparent layer or returned to the active layer (Abstract, line 10-17).

Fig. 15 of Watanabe shows a cross-sectional view of an AlGaN type LED including an AlN buffer layer 301, an n-type GaN cladding layer 302, an n-type GaInN light-emitting

layer 303, a p-type GaN cladding layer 304 and a p-type AlGaN total reflection layer 305 that are formed on a sapphire substrate 300 in order, by the MOCVD method (col. 14, lines 20-27).

Claim 21 recites at least the features of "wherein the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level $Eg < 3.4 * (1-X) + 1.95 * X - 1.0 * X * (1-X)$, said light-emitting layer being devoid of an intentional impurity."

Nowhere does Watanabe teach or suggest a light-emitting layer consisting of $In_XGa_{1-X}N$: (1) having various formulations based on a mole fraction of indium, (2) emitting light of any particular wavelength, based on the mole fraction of indium, or (3) having a photon energy that is less than a conventional mathematical relationship, which determines the photon energy as a function of the mole fraction of indium for an $In_XGa_{1-X}N$ layer with no intentional impurities.

B. The Shakuda Reference

Shakuda discloses an $In_{0.15}$ $Ga_{0.85}N$ light emitting layer 5 that is made to generate blue light, which preferably has a wave length of about 470 nm.

Shakuda also discloses, "the $In_{0.15}$ $Ga_{0.85}N$ light emitting layer 5 contains zinc (Zn) as an additive. If the mixed ratio (mixed crystal ratio) of In to Ga in the light emitting layer increases, the wave length of the light generated at this layer 5 also increase. Similarly, if the amount of Zn added to the $In_{0.15}$ $Ga_{0.85}N$ layer 5 increases, the wave length of the light generated at this layer 5 also increases."

Claim 21 recites at least the features of "wherein the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level $Eg < 3.4 * (1-X) + 1.95 * X - 1.0 * X * (1-X)$, said light-emitting layer being devoid of an intentional impurity."

Shakuda fails to cure the deficiencies of Watanabe. Although the Examiner asserts that the photon energy of the preferred wavelength of Shakuda (i.e., $\lambda = 470$ nm) is less than that calculated by the conventional mathematical relationship when using the mole fraction of indium of 0.15 of Shakuda, Applicants respectfully submit that the Examiner has failed to

consider the effects of the Zn added to the $In_{0.15}Ga_{0.85}N$ light emitting layer 5 upon the emitted wavelength.

Shakuda discloses that the wavelength of the light emitted from the $In_{0.15}Ga_{0.85}N$ layer increases with the amount of Zn added. As Shakuda does not teach or suggest what amount of Zn is added or how much the emitted light wavelength is lengthened by the added Zn, let us assume, *arguendo*, that the $In_{0.15}Ga_{0.85}N$ layer without Zn emits light of approximately 400 nm and that the addition of Zn shifts the wavelength by 70 nm to give the preferred emitted wavelength of 470 nm of Shakuda. Thus, an emitted wavelength of 400 nm, due only to the $In_{0.15}Ga_{0.85}N$ layer, would correspond to a photon energy, Eg, of 1239.8/400 = 3.0995 eV, which is larger than the photon energy level of 3.055 calculated from the conventional mathematical relationship based on a mole fraction of indium of 0.15 for an $In_{0.15}Ga_{0.85}N$ layer without any intentional impurities. Under these assumptions, the photon energy of Shakuda would be greater than that calculated from the conventional mathematical relationship and in contrast to the claimed subject matter of claim 21.

In summary, it is clear that the mole fraction of indium disclosed by Shakuda cannot be used with the conventional mathematical relationship between the mole fraction of indium and the photon energy level of emitted light because the conventional mathematical relationship is based on a light-emitting layer of $In_XGa_{1-X}N$ without any intentional impurities, while the light-emitting layer of $In_{0.15}Ga_{0.85}N$ of Shakuda contains an undisclosed amount of Zn.

For at least the reasons outlined above, Watanabe and Shakuda, either individually or in combination, do not disclose every feature of claim 21. Accordingly, Watanabe and Shakuda, either individually or in combination, fail to render obvious the subject matter of claim 21 and claims 22-27, which depend from claim 21, under 35 U.S.C. §103(a). Withdrawal of the rejection of claims 21-27 under 35 U.S.C. §103(a) as unpatentable over Watanabe in view of Shakuda is respectfully solicited.

C. The Ishikawa Reference

Ishikawa discloses a semiconductor light emitting diode having an n-type GaN semiconductor layer, a GaN-based active layer and a p-type GaN-based semiconductor layer

on a sapphire substrate, in which the cathode is formed on the n-type GaN semiconductor layer and an electrode wiring extends from the top of the p-type GaN-based semiconductor layer to from a capacitor (Abstract, lines 1-10).

Claim 21 recites at least the features of "wherein the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level $Eg < 3.4 * (1-X) + 1.95 * X - 1.0 * X * (1-X)$, said light-emitting layer being devoid of an intentional impurity."

Nowhere does Ishikawa teach or suggest a light-emitting layer consisting of $In_XGa_{1-X}N$: (1) having various formulations based on a mole fraction of indium, (2) emitting light of any particular wavelength, based on the mole fraction of indium, or (3) having a photon energy that is less than a conventional mathematical relationship, which determines the photon energy as a function of the mole fraction of indium for an $In_XGa_{1-X}N$ layer with no intentional impurities, as claimed by claim 21.

As argued above in response to the rejection of claims 21-27 over Watanabe and Shakuda, nowhere do Watanabe and Shakuda teach or suggest the feature of "wherein the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level $Eg < 3.4 * (1-X) + 1.95 * X - 1.0 * X * (1-X)$," as recited in claim 21. Therefore, Watanabe, Shakuda, and Ishikawa, either individually or in combination, do not disclose every feature of claim 21. Accordingly, Watanabe, Shakuda, and Ishikawa, either individually or in combination, fail to render obvious the subject matter of claim 21 and claims 28-31, which depend from claim 21, under 35 U.S.C. §103(a). Withdrawal of the rejection of claims 28-31 under 35 U.S.C. §103(a) as unpatentable over Watanabe as modified by Shakuda as applied to claim 21 and further in view of Ishikawa is respectfully solicited.

D. The Nitta Reference

Nitta discloses a gallium-nitride-based blue light emitting element having a first gallium-nitride-based semiconductor layer containing impurities of a first conductivity type, a gallium-nitride-based semiconductor active layer that is substantially intrinsic, and a second gallium-nitride-based semiconductor layer containing impurities of a second conductivity

type that is opposite to the first conductivity type, which are formed according to a thermal CVD method and are left in an inert gas to cool by themselves.

Claim 21 recites at least the features of "wherein the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level $Eg < 3.4 * (1-X) + 1.95 * X - 1.0 * X * (1-X)$, said light-emitting layer being devoid of an intentional impurity."

Nowhere does Nitta teach or suggest a light-emitting layer consisting of $In_XGa_{1-X}N$: (1) having various formulations based on a mole fraction of indium, (2) emitting light of any particular wavelength, based on the mole fraction of indium, or (3) having a photon energy that is less than a conventional mathematical relationship, which determines the photon energy as a function of the mole fraction of indium for an $In_XGa_{1-X}N$ layer with no impurities, as claimed by claim 21.

As argued above in response to the rejection of claims 21-27 over Watanabe and Shakuda, nowhere do Watanabe and Shakuda teach or suggest the feature of "wherein the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level $Eg < 3.4 * (1-X) + 1.95 * X - 1.0 * X * (1-X)$," as recited in claim 21. Therefore, Watanabe, Shakuda, and Nitta, either individually or in combination, do not disclose every feature of claim 21. Accordingly, Watanabe, Shakuda, and Nitta, either individually or in combination, fail to render obvious the subject matter of claim 21 and claim 32, which depends from claim 21, under 35 U.S.C. §103(a). Withdrawal of the rejection of claim 32 under 35 U.S.C. §103(a) as unpatentable over Watanabe as modified by Shakuda as applied to claim 21 and further in view of Nitta is respectfully solicited.

III. CONCLUSION

In view of the foregoing, Applicant submits that claims 21-32, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance,

the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 2/10/03

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend claim 21 as follows:

21. (Twice Amended) A method of manufacturing a light-emitting device, said method comprising:

forming a light-emitting layer comprised of $In_XGa_{1-X}N$ on a sapphire substrate,

wherein the light-emitting layer has an indium mole fraction X and emits light of wavelength (nm) = 1239.8/Eg (eV), such that the emitted light has an energy level Eg < 3.4 * (1-X) + 1.95 * X -1.0 * X * (1-X), said light-emitting layer being devoid of an intentional impurity.